CLAIMS

What is claimed is:

1. A method for detecting faults in an electric power-assisted steering system, the method comprising the steps of:

determining a voltage vector of an electric power-assisted steering motor;

measuring a current vector of the electric power-assisted steering motor;

defining an acceptable angular relationship between the voltage vector and the current vector;

comparing an angle between the measured current vector and the determined voltage vector; and

indicating a fault if the angle does not meet the acceptable angular relationship.

2. The method of claim 1, wherein the indicating step indicates a fault only where the fault repeats itself a predetermined number of times.

3. The method of claim 1, further comprising a step of detecting a rotational direction of the electric power-assisted steering motor, and wherein the defining step includes a first acceptable angular relationship for a positive motor rotational direction where the angle of the voltage vector must lead the angle of the current vector, a second acceptable angular relationship for a negative motor rotational direction where the angle of the voltage vector must lag the angle of the current vector, and a third acceptable angular relationship for a substantially zero motor rotational direction where the angles of the voltage and current vectors are substantially in-phase.

4. The method of claim 1, wherein the determining step includes the substeps of measuring a voltage pulse width output from the motor and checking the measured pulse width against a commanded pulse width, wherein if a difference in the measured and commanded pulse widths exceeds a predetermined error limit further comprising a step of indicating a fault.

5. The method of claim 4, wherein the measured pulse widths are used in determining the output voltage vector of the motor.

6. The method of claim 1, further comprising a step of detecting a position of the electric power-assisted steering motor, and wherein the defining step includes defining an acceptable angular relationship between the motor position and the current vector, and wherein the comparing step includes comparing an angle between the measured current vector and the detected motor position, and wherein the indicating step includes indicating a fault if the angle between the measured current vector and the motor position does not meet the acceptable angular relationship for the measured current vector and the motor position.

7. The method of claim 6, further comprising the step of inputting a torque direction, and wherein the defining step includes a primary acceptable angular

relationship between the current vector and motor position for a positive input torque direction where the angle of the current vector must lead the motor position by a current alignment angle, and a secondary acceptable angular relationship between the current vector and motor position for a negative input torque direction where the angle of the current vector must lag the motor position by the current alignment angle.

8. The method of claim 1, wherein the measuring step includes the substeps of measuring a torque drive current to the motor and checking the torque drive current against a commanded torque drive current, wherein if a difference in the measured and commanded torque drive currents exceeds a predetermined error limit further comprising a step of indicating a fault.

9. The method of claim 1, wherein the method is only performed when the motor is not operating under a flux-weakened condition.

10. A method for detecting faults in an electric power-assisted steering system, the method comprising the steps of:

determining a voltage vector of an electric power-assisted steering motor;

measuring a current vector of the electric power-assisted steering motor;

detecting a rotational direction and positional angle of the electric power-assisted steering motor;

defining acceptable angular relationships between the voltage and current vectors and between the motor position and the current vector; and

comparing a first angle between the measured current vector and the determined voltage vector and a second angle between the motor position and the current vector; and

indicating a fault if the first and second angles do not meet the associated acceptable angular relationships.

11. The method of claim 10, further comprising the step of inputting a torque direction, and wherein the defining step includes a first acceptable angular relationship between the current and voltage vectors for a positive motor rotational direction where the angle of the voltage vector must lead the angle of the current vector, a second acceptable angular relationship between the current and voltage vectors for a negative motor rotational direction where the angle of the voltage vector must lag the angle of the current vector, a third acceptable angular relationship between the current and voltage vectors for a substantially zero motor rotational direction where the angles of the voltage and current vectors are substantially in-phase, a fourth acceptable angular relationship between the current vector and motor position for a positive torque direction where the angle of the current vector must lead the motor position by a current alignment angle, and a fifth acceptable angular relationship between the current vector and motor position for a negative torque direction where the angle of the current vector must lag the motor position by the current alignment angle.

12. The method of claim 10, wherein the determining step includes the substeps of measuring a voltage pulse width output from the motor to determine the output voltage vector of the motor and checking the measured pulse width against a commanded pulse width, wherein if a difference in the measured and commanded pulse widths exceeds a predetermined error limit further comprising a step of indicating a fault.

13. The method of claim 10, wherein the measuring step includes the substeps of measuring a torque drive current to the motor and checking the torque drive current against a commanded torque drive current, wherein if a difference in the measured and commanded torque drive currents exceeds a predetermined error limit further comprising a step of indicating a fault.

14. A fault detection system for an electric power-assisted steering motor, the fault detection system comprising:

a voltage vector detector coupled to the motor that determines a voltage vector of the motor;

a current vector detector coupled to the motor that measures a current vector of the motor; and

a processor coupled to the detectors, the processor defines an acceptable angular relationship between the voltage vector and the current vector, and inputs the voltage and current vectors from the associated detectors to compare an angle therebetween, wherein the processor indicates a fault if the angle does not meet the acceptable angular relationship.

15. The system of claim 14, further comprising a motor rotational direction detector coupled between the motor and the processor, and wherein the processor defines a first acceptable angular relationship for a positive motor rotational direction where the angle of the voltage vector must lead the angle of the current vector, a second acceptable angular relationship for a negative motor rotational direction where the angle of the voltage vector must lag the angle of the current vector, and a third acceptable angular relationship for a substantially zero motor rotational direction where the angles of the voltage and current vectors are substantially in-phase.

16. The system of claim 14, wherein the voltage vector detector operates to measures a voltage pulse width output from the motor to determine the output voltage vector, and wherein the processor operates to check the measured pulse width against a commanded pulse width from the processor, wherein if a difference in the measured and commanded pulse widths exceeds a predetermined error limit the processor indicates a fault.

17. The system of claim 14, further comprising a motor position detector coupled between the motor and the processor, and wherein the processor defines an acceptable angular relationship between the motor position and the current vector, and inputs the motor position and the current vector and compares an angle therebetween, wherein the processor indicates a fault if the angle between the measured current vector and the motor position does not meet the acceptable angular relationship for the measured current vector and the motor position.

18. The system of claim 17, further comprising a torque directional sensor, and wherein the processor defines a primary acceptable angular relationship between the current vector and motor position for a positive directional torque from the torque sensor where the angle of the current vector must lead the motor position by a current alignment angle, and a secondary acceptable angular relationship between the current vector and motor position for a negative directional torque from the torque sensor where the angle of the current vector must lag the motor position by the current alignment angle.

19. The system of claim 14, wherein the current sensor includes torque detection, wherein the processor inputs a detected torque from the torque detection and checks the torque drive current against a commanded torque drive current, wherein if a difference in the measured and commanded torque drive currents exceeds a predetermined error limit the processor indicates a fault.

20. The system of claim 14, wherein the acceptable angular relationships used in fault detection are dynamically adjustable depending on steering conditions.